TABLE 2.—*Tabulated data of sounding-balloon ascents made at Broken Arrow, Okla., during December, 1929*—Continued

DECEMBER 29, 1929

Time 90th mer.	Altitude (M. S. L.)	Pressure	Temperature	$\frac{\Delta t}{100\text{ m.}}$	Humidity: Relative	Humidity: Vapor pressure	Wind: Direction	Wind: Velocity	Remarks
P. m.	M.	Mb.	° C.		P. ct.	Mb.		M. p. s.	
3:44	233	991.9	16.6	-------	32	6.05	sw.	5.8	Cloudless.
	500	961.1	14.6	-------	32	5.32	wsw.	8.6	
3:47	928	913.3	11.5	0.73	32	4.34	wsw.	10.6	
	1,000	905.4	11.0	-------	32	4.20	wsw.	11.3	
3:49	1,490	853.5	7.8	0.66	32	3.39	w.	19.0	
	1,500	852.5	7.8	-------	32	3.39	w.	19.0	
	2,000	802.3	6.9	-------	30	2.98	wnw.	17.5	
3:52	2,122	790.4	6.7	0.17	30	2.94	wnw.	16.9	
	2,500	754.7	4.9	-------	31	2.68	wnw.	16.2	
	3,000	709.7	2.4	-------	32	2.32	nw.	14.1	
3:59	3,711	649.9	−1.0	0.48	34	1.91	nw.	17.0	
	4,000	626.7	−2.5	-------	34	1.69	nw.	19.3	
	5,000	551.9	−7.7	-------	35	1.12	wnw.	20.8	
4:04	5,025	550.2	−7.8	0.52	35	1.11	wnw.	20.8	
	6,000	484.3	−16.2	-------	32	0.48	nw.	18.8	
4:11	6,626	446.0	−21.6	0.86	30	0.27	nnw.	23.2	
	7,000	423.8	−25.0	-------	30	0.19	nnw.	25.0	
4:15	7,728	383.1	−31.8	0.93	30	0.10	nw.	22.5	
	8,000	369.0	−33.7	-------	30	0.08	nw.	21.2	
	9,000	320.1	−40.9	-------	29	0.03	n.	26.6	
4:22	9,686	289.7	−45.8	0.66	28	0.02	n.	30.0	Tropopause.
	10,000	276.3	−45.9	-------	28	0.02	nnw.	23.1	
4:24	10,339	262.8	−46.0	0.03	28	0.02	nw.	19.8	
	11,000	238.5	−48.0	-------	27	0.01	nw.	29.6	
	12,000	205.5	−50.9	-------	26	0.01	nw.	34.6	
4:31	12,828	181.0	−53.4	0.30	25	0.01	nnw.	20.1	
	13,000	176.5	−54.0	-------	25	0.01	nnw.	23.6	
	14,000	151.4	−57.5	-------	25	(1)	nw.	20.2	
	15,000	129.5	−61.1	-------	25	(1)	nw.	20.0	
4:42	15,738	115.4	−63.7	0.35	25	(1)	nnw.	17.6	
	16,000	110.7	−63.8	-------	25	(1)	nnw.	13.3	
	17,000	94.4	−64.0	-------	25	(1)	nnw.	11.8	
4:50	17,555	86.4	−64.1	0.02	25	(1)	nnw.	14.6	
	18,000	80.5	−63.4	-------	25	(1)	nnw.	14.4	
4:54	18,550	73.6	−62.6	−0.15	25	(1)	nw.	20.2	

[1] Less than 0.01 mb.

LITERATURE CITED

(1) Annals Harvard College Observatory, Vol. 68, Pt. 1

(2) Monthly Weather Review, June 1929, pp. 231–246.

(3) Monthly Weather Review, July 1927, pp. 293–307.

WIND VELOCITIES AT DIFFERENT HEIGHTS ABOVE GROUND

By C. F. MARVIN

A correspondent inquires whether the Weather Bureau has made any investigations to determine the relative wind velocity as indicated by an anemometer at different heights above ground. The following reply was made:

Replying to your telegram of August 21, requesting information as to velocities indicated by anemometers at different heights above the ground, you are advised that the Weather Bureau has conducted a number of inconclusive comparisons of wind velocities measured at its stations at different elevations, with the hope that some rational rule would result for coordinating the indications at various heights. Thus far, however, we have not felt justified in announcing any such coordination or formula, so to speak, for reduction to uniform elevations.

The demands upon the bureau for service to the public in great metropolitan and other city areas compel us to occupy quarters such as can be procured in these cities. It is recognized that the wind-velocity records obtained under these conditions are not entirely satisfactory. If one contemplates the skyline of the modern great city, it is obvious that the flow of air over the house tops and among the skyscrapers is turbulent and difficult to measure with any specially significant result. On the other hand, observations made in the open country or in cities of moderate population necessarily represent only those localities, and can not, with assurance, be applied to other localities. Our policy, therefore, has been to submit records as obtained, without attempting to modify or adjust these records, and to supply to any interested person a complete description of the environment and nature of exposure of the anemometer at the particular station, leaving it to the user of the records to make such correlations with environment as may seem to him to be best.

Apart from the foregoing, you are further advised that various comparative observations have been made for winds at different altitudes over an open plain or country, and one formula for increase of velocity is approximately

$$V = V_o\left(\frac{h}{h_o}\right)^{\frac{1}{5}}$$

where h is the height in meters above the surface for which the velocity V in meters per second is to be computed, and h_o the known height (not less than 16 meters) at which the velocity V_o is measured. There are still other relations that cover the general increase in velocity upward for much greater elevations. I infer, however, that you are interested only in elevations of several hundred feet above the actual surface.

THE WEATHER AND RADIO

By W. J. HUMPHREYS

It appears to be human nature to explain whatsoever is not understood by attributing it to something that is still more mysterious, or even to the supernatural. At any rate this is a very common human practice, as excellently illustrated by the many appeals that have come to the Weather Bureau to have radio broadcasting suppressed, on the ground that it is burning up the water vapor of the air and thereby, or in some other manner, greatly decreasing the amount of rainfall, and thus causing disastrous droughts.

On the other hand, some who were bothered with more rain than needed were equally insistent that radio is the cause of excessive precipitation and floods, and urged that therefore all wireless communication be forthwith and preemptorily forbidden.

Let us analyze somewhat nature's way of making rain, and from that see, if we can, just how and to what extent radio does affect precipitation.

1. The first action necessary to precipitation is evaporation, by which water in the gaseous form is gotten into and made a portion of the atmosphere. Now the chief factors that affect the rate of evaporation are: (*a*) Temperature of the evaporating water; (*b*) area of the evaporating surface; (*c*) wind velocity; (*d*) dryness of the air. Of course no one in the neighborhood of a powerful "sending station" ever claims that any lake, reservoir or other body of water near-by, spreads over a lot more ground when the station is in operation than it does when the station is silent. He knows, too, that the temperature of the water does not appreciably vary, if at all, with the wireless activity. Neither, so far as any one can observe, does the wind round about a wireless station change with the amount of its broadcasting or receiving. We shall see presently, too, that radio does not alter the dryness of the air.

Obviously, since radio does not affect any of the things that themselves make for evaporation, neither does it affect evaporation itself.

2. The next step by nature in producing rain is to condense the water vapor out of the air in the form of drops. To this end two things are necessary: (*a*) One of these is the presence of condensation nuclei, that is, excessively small particles of sea salt, certain kinds of land dust, or other substances that readily take up water vapor. These nuclei about which cloud droplets form always are in the atmosphere in superabundance. Besides, they are not produced by wireless waves, as we know by direct experiment. (*b*) The other essential to

get the water vapor condensed is an adequate cooling of the vapor, and with it (unavoidably) the other elements of the atmosphere. But the temperature of the air does not go down about an active wireless station any more rapidly, nor to a lower degree, than it does at other similarly located places.

Evidently, then, radio does not take water vapor out of the air and make it drier, thus increasing evaporation and subsequent rainfall. Neither does it prevent or decrease rainfall since it has no effect on any of the factors of either evaporation or condensation.

Again, drought may prevail in one region at the same time that another, with equal wireless facilities, is being flooded. Furthermore, droughts and floods, such as we now have, prevailed time and again throughout the world long before wireless was ever dreamed of.

Finally, from purely theoretical considerations, we know that the relatively small amount of energy used in broadcasting is not sufficient by millions of fold to produce any appreciable change in the amount of precipitation over either the United States as a whole, or even any one of its units.

However much radio may be affected by the weather, especially by the thunderstorm, no element of the weather is affected in turn by radio. We know this from experiment and observation, and we know it from theory as well.

AN ERROR IN THE MAXIMUM-THERMOMETER READING

By W. J. HUMPHREYS

In the case of the mercurial maximum thermometer that breaks its column at a point of constriction the reading always is too low if made after appreciable cooling. This is well known, but perhaps not as generally recognized and fully understood as it might be.

Let

- V_m = the stem volume between consecutive degree marks at the time of maximum temperature.
- V_t = the stem volume between consecutive degree marks when the temperature is t.
- t_o = the stem reading at the point of break of column.
- t = the temperature at time of reading.
- t_m = the true maximum temperature.
- t'_m = the maximum temperature as read.
- M = the coefficient of the *volume* expansion of mercury.
- G = the coefficient of the *volume* expansion of the thermometer stem—threefold the coefficient of its linear expansion.

The volume of the mercury column at the time of maximum temperature, is, of course, the volume of that portion of the stem then filled. That is, at the temperature t_m

$$\text{Volume of mercury} = \text{volume of glass} = V_m(t_m - t_o)$$

At the time of reading, however, or when the mercury has cooled from t_m to t, the volume of this same mass of mercury is

$$V_m(t_m - t_o) - MV_m(t_m - t_o)(t_m - t), \text{ or } V_m(t_m - t_o)\{1 - M(t_m - t)\}$$

while the original occupied stem volume has become

$$V_m(t_m - t_o)\{1 - G(t_m - t)\}$$

Hence the apparent or virtual shrinkage of the mercury, being the difference between the true shrinkage of the mercury and the true shrinkage of the glass, is

$$V_m(t_m - t_o)(M - G)(t_m - t)$$

Now the error of the reading evidently is the number of the unit stem volumes (volume between consecutive degree marks) whose total volume at the time of observation, when the temperature is t, is equal to the virtual shrinkage of the mercury since the temperature was t_m. Let this number be x, then

$$\begin{aligned} xV_t &= V_m(t_m - t_o)(M - G)(t_m - t) \\ &= V_m(t'_m + x - t_o)(M - G)(t'_m + x - t) \end{aligned}$$

From this equation the numerical value of x, the error in question in degrees, could be computed if we knew the ratio of V_m to V_t, since the values of all the other terms are known. Clearly,

$$V_t = V_m\{1 - G(t'_m + x - t)\}$$

But since G is very small, 0.000025, about, per degree centigrade, and $t_m - t$ seldom large, say, 20° C. at most, it follows that no observable error will be made by assuming V_t and V_m to be exactly equal to each other. With this assumption the value of x is readily computed.

To simplify, let

$$\begin{aligned} M - G &= d \\ t'_m - t_o &= a \\ t'_m - t &= b \end{aligned}$$

Then

$$x = (a + x)d(b + x)$$

Finally, since x is very small in comparison with either a or b, we can, without measureable error, write

$$\begin{aligned} x &= adb \\ &= (t'_m - t_o)\ (M - G)\ (t'_m - t) \end{aligned}$$

the form in which the value of this error commonly is expressed.

In practice this error, or value of x, seldom amounts to more than 0.1° F. or 0.2° F., and therefore for most purposes is negligible. It might be sufficient, however, to change a Weather Bureau's telegraphed value by 2°. Thus, suppose the reading taken just after maximum, is 91° +, F., and the reading some time later, following considerable cooling, 91° −, F. Owing to code exigencies the first would be reported as 92° F., and the second as 90° F. Fortunately, though, even this occasional error is of little importance, since it is the permanent station record of actual readings and not the ephemeral telegraphed reports that are considered in climatological and kindred studies.

In short this particular error of the maximum thermometer is of little to no importance in meteorology. Nevertheless, it is pleasant to know that there is such an error and reassuring to understand clearly when and why it may be ignored.